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REEXAMINATION OF *SIMULIUM (PSILOPELMIA)* ENDERLEIN (DIPTERA: SIMULIIDAE) OF AMERICA NORTH OF MEXICO

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Abstract.—Ten species in the black fly subgenus *Psilopelmia* of *Simulium* in the United States and Canada are treated taxonomically. *Simulium notatum* Adams, known only from two females collected in western Arizona at the turn of this century, has been rediscovered; the female is redescribed, and the remaining life stages after the egg are described for the first time. *Simulium clarum* Dyar and Shannon, known only from three cotype males, is resurrected from synonomy; the male is redescribed, and the remaining life stages above the egg are described for the first time. *Simulium longithallum* Díaz Nájera and Vulcano, not previously known from the United States, is reported from two locations in eastern Arizona, and all life stages after the egg are redescribed. At least one life stage of these additional species of *Psilopelmia* Enderlein can easily be confused with those of the eight currently recognized species recorded from the contiguous United States and Canada. Updated keys are provided that will facilitate separation of pupae and both adults. Diagnoses are provided for larvae in the rare instances where identification is relatively straightforward for all instars.

Key Words: North America, aquatic insects, Simuliidae, streams, rivers

Peterson (1993) and Coscarón et al. (1995, 1996) revised the Nearctic and Neotropical species of *Psilopelmia* Enderlein, respectively. Peterson (1993) described two unusual species, *S. robynae* and *S. labellei*, from the Rio Grande River system, redescribed six others, and provided keys for the separation of all life stages after the egg. Coscarón et al. (1995) treated eight species known from the Caribbean Islands and Central and South America and provided keys for the identification of all life stages after the egg. Coscarón et al. (1996) treated 21 species known from the Americas south of the United States. In this work, they redescribed 20 species; described one species, *S. bobpetersoni*, as new to science; established synonymies of six species; provided well illustrated keys to all life stages after the larva; and inferred a phylogeny of the group using morphological characters.

Two views exist on the placement of species within the related subgenera *Psilopelmia* and *Ectemnaspis* Enderlein. Crosskey's (1988) definition of *Psilopelmia* is broad compared to that of Coscarón et al. (1995, 1996), whereas his concept of *Ectemnaspis* is more restricted. The limits set for the subgenus by Coscarón et al. (1995) reduce the size of *Psilopelmia* to approximately one half that recognized by Crosskey (1988). The majority of species removed by Coscarón (1987) and Coscarón et al. (1995) were transferred to four species groups of *Ectemnaspis* (Coscarón 1984, 1990). Coscarón et al. (1995) defined *Psilopelmia* predominantly on color patterns of the male and female scutum and female abdomen.

Evidence for a *Psilopelmia* plus *Ectemnaspis* clade includes similar cibarial armature and features of the anal lobe (Coscarón et al. 1996). The subgeneric status of all North American species previously assigned to *Psilopelmia* remains unchanged.

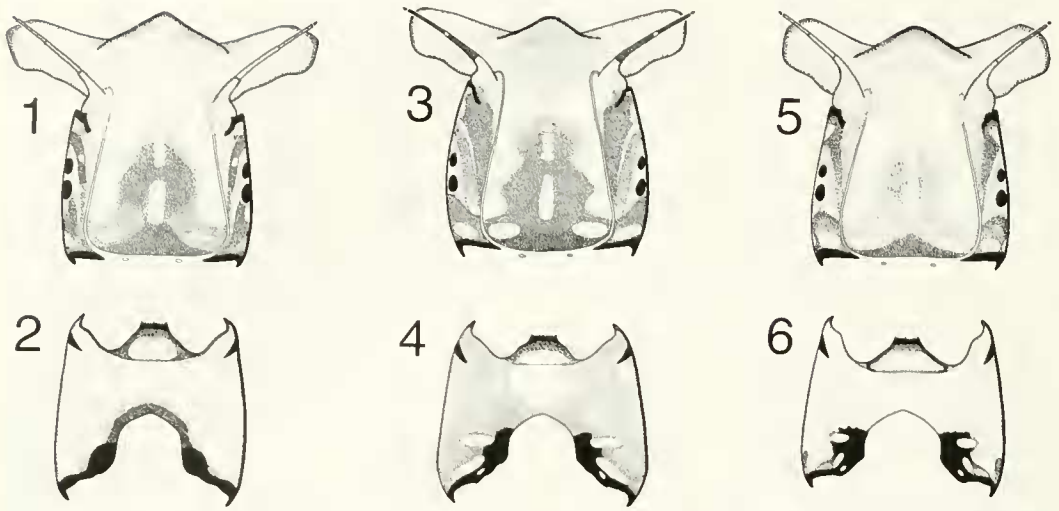
Females of *Psilopelmia* are mammalophilic and pests of livestock, and more rarely humans, in western North America. Anderson and Voskuil (1963) reported a significant reduction in milk production in cattle in Merced County, California, caused by the aggressive feeding behavior of a species they identified as *S. trivittatum* (= *S. clarum*). They estimated 500–800 females per animal at some periods in the late afternoon. Anderson and Yee (1995) observed *S. clarum* (as *S. trivittatum*) and *S. griseum* feeding on horses in northern California. Females were predominantly seen taking blood from the undersides of horses, although substantial numbers were attracted to ears of animal models. Peak catches occurred from September through October. Francy et al. (1988) isolated vesicular stomatitis virus (VSV) in Colorado from a pooled sample of simuliids that contained *S. bivittatum*. Two Nearctic species, *Simulium bivittatum* and *S. clarum* (as *S. trivittatum*), have been reported feeding upon humans in substantial numbers in Oregon and California, respectively (Cole and Lovett 1921, Essig 1938, Anderson and Voskuil 1963, Peters and Womeldorf 1966).

This manuscript is intended to provide the means to identify species of the subgenus *Psilopelmia* in North America and to facilitate the inclusion of *S. clarum* and *S. longithallum* in a book on the black flies of North America being prepared by P. H. Adler, D. C. Currie, and D. M. Wood. In light of current investigations revolving around species of *Psilopelmia* as potential vectors of vesicular stomatitis virus, it is important that keys, particularly those to females, be updated with respect to new taxonomic data.

Materials and Methods

Life-stage descriptions follow those of Adler and Currie (1986). Taxonomic terms predominantly follow those of Peterson (1981). Preimaginal material initially fixed in Carnoy's solution was transferred to 80% ethanol for permanent storage. Adults were either dried in a frost-free freezer at −20°C or dehydrated with absolute ethanol and dried using Peldri II (Ted Pella, Inc.) or hexamethyldisilazane (HMDS) (Polysciences, Inc.). Full series of *S. clarum*, *S. longithallum*, and *S. notatum* are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; The Natural History Museum, London; the Canadian National Collection, Ottawa; the Snow Entomological Museum, Lawrence, Kansas; and the University of Arizona Insect Collection, Tucson, Arizona. Additional material is housed in the author's personal collection. Institutions that furnished material for examination are denoted as follows: Canadian National Collection (CNC), Los Angeles County Museum (LACM), National Museum of Natural History, Smithsonian Institution (USNM), University of Arizona (UAZ); and University of Idaho (UID). The synonymies provided for each species include only misidentifications of either systematic or medical/veterinary importance. County names in the material examined sections of this paper enclosed by parentheses are not present on the locality labels accompanying the specimens and were inferred by the author.

Some of the keys rely heavily upon content and, to a lesser extent, illustrations in Peterson (1993). Although there appear to be interspecific differences in larval coloration in Carnoy's-fixed larvae, limited availability of such material precludes incorporation of this information into these keys. Additional characters, such as polytene chromosome rearrangements, are sorely needed to more adequately identify larvae of *Psilopelmia*. Line drawings were rendered by the author with the aid of an



Figs. 1–6. Larval head capsules. 1, *Simulium clarum*, dorsal view. 2, *S. clarum*, ventral view. 3, *S. longithallum*, dorsal view. 4, *S. longithallum*, ventral view. 5, *S. notatum*, dorsal view. 6, *S. notatum*, ventral view.

MTI CCD72 imaging system connected to an Olympus SZH10 stereo microscope. Length and width measurements were made either using this imaging system or an ocular micrometer in an Olympus SZH zoom stereomicroscope. Terminalia, mouthparts, and legs were cleared in hot 85% lactic acid to facilitate visibility and interpretation. The pupae used to make the scanning electron micrographs were dehydrated with absolute ethanol, dried using HMDS, mounted on brass pegs covered with glue, and sputter-coated with gold. The micrographs of pupal gills were made with an International Scientific Instruments model DS-130 scanning electron microscope.

Species Accounts

Simulium (*Psilopelmia*) *bivittatum* Malloch (Figs. 8, 21, 48, 54)

The larva is not reliably distinguished from those of other species unless mature and the gill is dissected out and examined. The anteriorly directed dorsal filament and anteroventrally directed petiolate pair of filaments of the middle group of gill filaments and thickened base of the dorsal group of filaments (Figs. 8, 21) distinguish the pupa from the others treated herein. The female is separated from those of all species, except *S. clarum*, by the combination of scutal coloration and length of the ventral process of the anal lobe. Females are not reliably separated from those of *S. clarum*, though dark-striped females are much rarer in *S. bivittatum* (see discussion under *S. clarum*). Males are separated from all others, except *S. clarum*, by the matte black scutum (rarely glabrous orange) with anterior crescent-shaped silvery blue stripes extended ⅓–½ the distance to the base of the wing, yellow stem vein setae, and shape of the ventral plate.

Color variation in this and other species was commonly observed and might be attributable to the water temperature of the preimaginal habitat, as was observed by Wilson et al. (1992) with *S.* (*Edwardsellum*) *sirbanum* Vajime and Dunbar. Orange variants (typically males) are much more common during the summer months, and dark variants (typically females) are much more common during the spring and autumn months.

The pupal keys in Peterson (1993) and Peterson and Kondratieff (1995) rely heavily on the shape and weaving of the cocoon for separation of the pupae of *S. bivittatum*,

S. griseum, and *S. venator.* I have observed variation in the thickness of the anterior collar between populations of *S. bivittatum* and *S. notatum* inhabiting slow-flowing versus fast-flowing habitats. The degree of strengthening in the anterior portion of the cocoon seems directly proportional to water velocity. Therefore, these characters are not suitable for taxonomic use. *Simulium bivittatum* is widely distributed across western North America, but its presence in California remains unconfirmed, as all material examined from there is *S. clarum.*

Material examined.—CANADA: ALBERTA: Milk River, 4 July 1964, G. C. & D. M. Wood—2 ♂ & 1 ♀ (dark) w/exuviae (CNC). St. Mary's River nr. Lethbridge, 29 June 1982, B. V. Peterson—1 ♂ & 1 ♀ (CNC). USA: ARIZONA: Cochise Co., San Pedro River at US Rt. 90, 7.5 miles E of Sierra Vista, 17 January 1991, E. W. Cupp & F. R. Ramberg—3 ♂, 2 ♀; 6 May 1991, C. A. Olson—3 ♂, 1 ♀, 18 March 1992—C. A. Olson—2 ♀; 20 August 1992—J. K. Moulton—2 ♂, 2 ♀; 17 October 1992, J. K. Moulton—13 ♂, 8 ♀; 14 November 1992, J. K. Moulton—6 ♂, 6 ♀; 21 November 1992, J. K. Moulton—4 pupae, 6 ♂ & 9 ♀ w/exuviae; 28 April 1993—J. K. Moulton—4 ♂, 6 ♀. Pima Co., Arivaca Creek at Arivaca Rd., 22 September 1992, C. A. Olson—3 ♂, 4 ♀; 3 October 1992, C. A. Olson—2 ♂, 2 ♀; 10 October 1992, J. K. Moulton—37 larvae, 29 pupae, 10 ♂ & 8 ♀ w/exuviae. Pinal Co., Aravaipa Creek at Aravaipa Rd., 5 September 1992, J. K. Moulton—1 ♂. Yavapai Co., 1 mi S of Boynton Cyn., 34°51′N, 111°50′W, 15 April 1991, N. L. Evenhuis—1 ♀ (CNC). Verde River at I-10, 16 June 1994, J. K. Moulton and D. G. Mead—184 larvae, 22 pupae. COLORADO: Yuma Co., Wray, 6 June 1963, G. C. & D. M. Wood—4 ♂ & 2 ♀ w/exuviae (CNC). IDAHO: Elmore Co., 3.5 mi. W of Hammett, 20 June 1964, W. F. Barr—1 ♀ (USNM); 7 mi. S of Sunnyside, 18 July 1967, L. S. Hawkins, Jr.—4 ♀ (USNM). Franklin Co., Treasureton Res., 17 June 1970, W. F. Barr—2 ♀ (USNM). Gooding Co., 6.5 mi. N of Gooding, W. F. Barr—2 ♀ (USNM). Blue Gulch, Hagerman, wind vane trap, 23 September 1932, 1 ♀ (USNM). NEW MEXICO: Catron Co., San Francisco River at US Rt. 180, 15 May 1995, J. K. Moulton—6 ♂ & 9 ♀ w/exuviae. UTAH: Uinta Co., Uinta River at Gusher, 1 July 1963, G. C. & D. M. Wood—2 ♂ (1 w/exuviae), 2 ♀ (CNC). WYOMING: Crook Co., Belle Fource River at Devil's Tower, 21 May 1993, K. Pruess—8 larvae, 3 pupae, 3 ♂ & 3 ♀ w/exuviae.

Simulium (Psilopelmia) clarum
Dyar and Shannon
(Figs. 1, 2, 7, 23–25, 30, 34, 39, 47, 53)

Eusimulium clarum Dyar and Shannon 1927: 21 (female, male, key, original description, figs. 38, 52–53), three "cotype" males.

Simulium (Lanea) bivittatum Wirth and Stone 1956: 405 (*nec* Malloch 1914), males, females, pupae, larvae, keys.

Simulium (Lanea) trivittatum Wirth and Stone 1956: 404 (*nec* Malloch 1914), males, females, pupae, larvae, keys.

Simulium (Psilopelmia) bivittatum Anderson and Voskuil 1963: 127 (*nec* Malloch 1914), biting cattle.

Simulium (Psilopelmia) trivittatum Anderson and Voskuil 1963: 127 (*nec* Malloch 1914), biting cattle and humans.

Simulium trivittatum Peters and Womeldorf 1966: 41 (*nec* Malloch 1914), biting humans.

Simulium (Psilopelmia) trivittatum Cole 1969: 110 (*nec* Malloch 1914), California records.

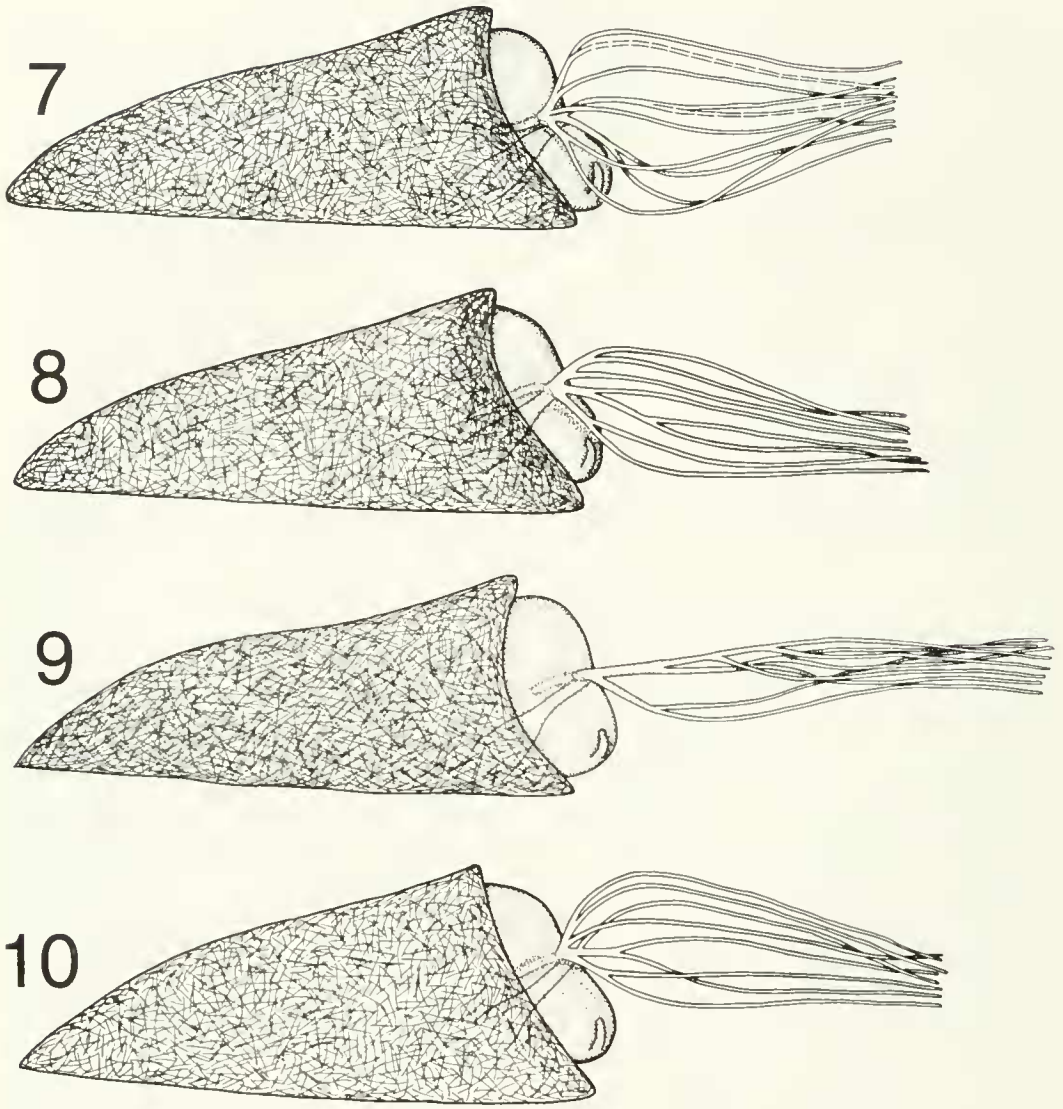
Simulium bivittatum Hall 1974: 65 (*nec* Malloch 1914), biology.

Simulium trivittatum Hall 1974: 65 (*nec* Malloch 1914), biology.

Simulium (Psilopelmia) bivittatum Peterson 1993: 308 (*nec* Malloch 1914), California records.

Simulium (Psilopelmia) trivittatum Peterson 1993: 341 (*nec* Malloch 1914), California records.

Simulium (Psilopelmia) trivittatum Ander-



Figs. 7–10. Pupae. 7, *Simulium clarum*. 8, *S. bivittatum*. 9, *S. longithallum*. 10, *S. notatum*.

son and Yee 1995: 28 (*nec* Malloch 1914), ex. horses, models, and flight traps.

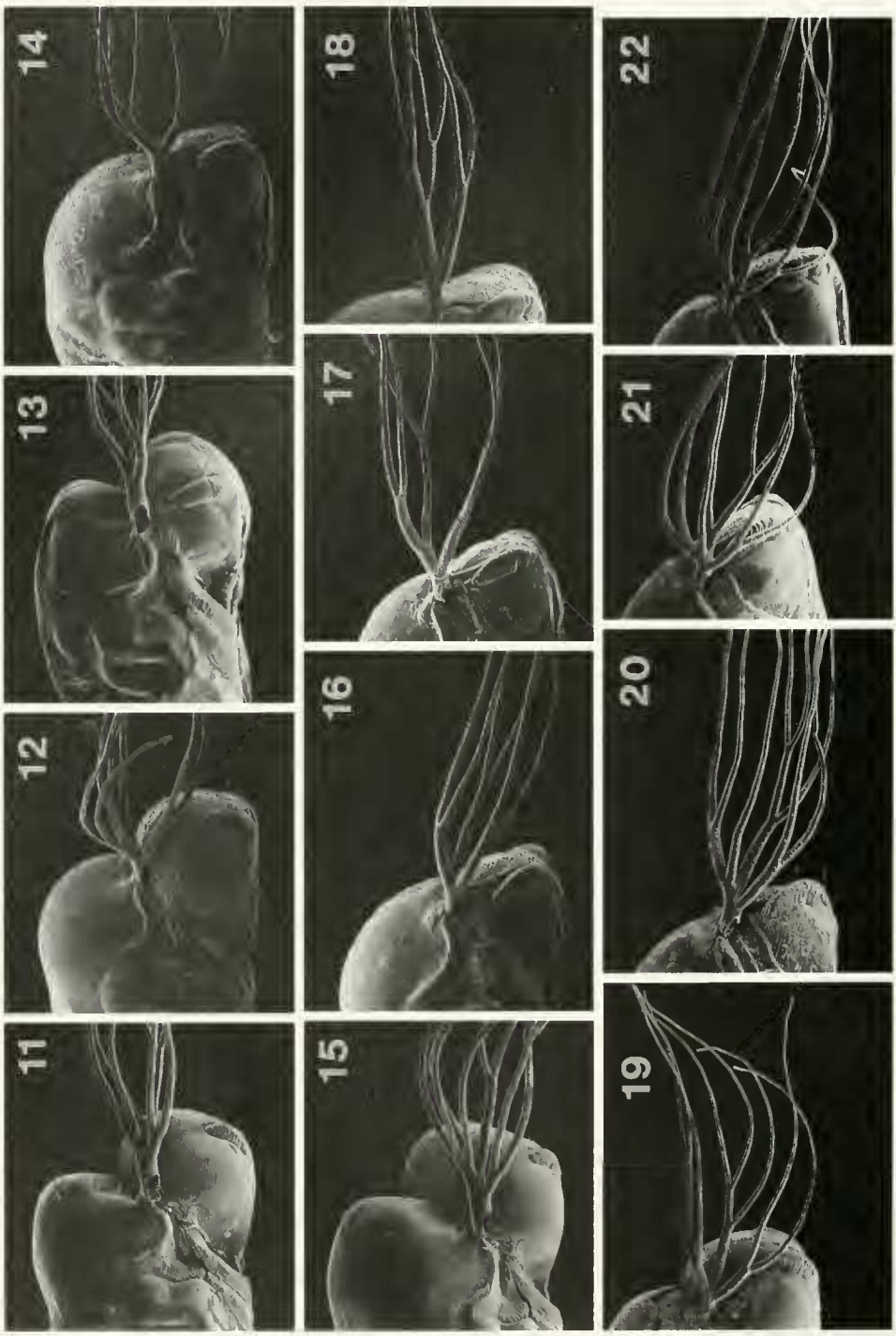
Simulium (*Psilopelmia*) *trivittatum* Yee and Anderson 1995: 7 (*nec* Malloch 1914), ex. horses, models, and flight traps.

Larva.—Length 5.0–5.8 mm ($\bar{x}$ = 5.6, n = 20). Body coloration variable, either pale green or gray with distinct, white intersegmental areas. Head capsule (Figs. 1, 2) pale yellowish brown; cephalic apotome variable, ranging from pale brown with dark brown areas restricted to area formed by the anteromedian, posteromedian, and anterolateral headspots and between posterolateral headspots (green larvae) to mostly dark brown in the region surrounding headspots (gray larvae); headspots paler than cephalic apotome; intensity of cephalic apotome pigmentation positively correlated with that of larval color. Antenna pale yellowish brown. Labral fan with 35–46 primary rays ($\bar{x}$ =

39, n = 20). Postgenal cleft oval, sometimes slightly pointed apically, extended about ⅓ distance to hypostomal groove, and with or without distinct brown border. Mandible with 6 apical teeth and 7–8 smaller subapical teeth; inner subapical ridge with bifid sensillum; upper time twice length and breadth of lower tine. Maxillary palpus cylindrical, moderately sclerotized, about 3 times longer than wide. Hypostoma (dorsal wall) with 13 teeth; a median tooth and 6 lateral teeth per side as follows: 3 small, subequally sized sublateral teeth, a corner tooth subequal in size to median tooth, and one pair of paralateral teeth; ventral hypostomal wall with 3–4 setae and 2–3 lateral serrations along lateral margin. Subesophageal ganglion darkly pigmented. Thoracic proleg with lateral sclerite lightly sclerotized, roughly square. Body of normal shape, with abdomen gradually expanded after segment-V. Anal papillae consisting of three simple lobes. Ventral tubercles approximately ⅛ depth of abdomen at attachment points. Anal sclerite X-shaped with anterior arms ½ length of posterior arms. Posterior proleg bearing 68–77 rows of 11–18 hooks.

Pupa (Fig. 7).—Length 2.5–3.0 mm ($\bar{x}$ = 2.8, n = 20). Cephalic plate with numerous, uniformly distributed granules. Anterodorsum of thorax with numerous granules and horizontal row of 3–4 simple or bifid trichomes. Gill (Figs. 23–25) ⅔–¾ length of pupa, comprised of 8–10 filaments; filaments branching 2+1, 2+1, 1+1 when 8-filamented (Fig. 25), 2+1, 1, 1+2, 1+1 when 9-filamented (Fig. 24), and 2+1, 1, 2+2, 1+1 when 10-filamented (Fig. 23); filaments uniformly thin, shallowly furrowed; middle group of 3–4 filaments with dorsal filament(s) directed slightly dorsally and ventral pair directed anteriorly or only very slightly anteroventrally. Tergites with randomly spaced microdenticles anteriorly. Tergite I with 2 fine setae per side; tergite II with 5–6 fine, scarcely perceptible setae per side, arranged in two closely spaced groups, two medial of lateral group of 3–4; tergite III with 4 retrorse hooks and three hook-like setae per side, hook-like setae consisting of two situated anterior to and one lateral to lateralmost retrorse hooks; tergite IV with 4 retrorse hooks and 1 lateral hook-like seta per side; tergite V with one lateral hook-like setae per side; tergite VI with 1 latitudinal row of spine-like setae and 1 lateral hook-like seta per side; tergite VII with median, latitudinal row of spine-like setae and 1 lateral hook-like seta per side; tergite VIII with latitudinal row of spine-like setae extended length of sclerite and 1 lateral hook-like seta; tergite IX with latitudinal row of spine-like setae and one, small terminal spine per side. Sternite IV with 1 spine-like seta per side; sternite V with 2 closely paired bifid spine-like setae near midline; sternites VI–VII each with 1 bifid and 1 simple spine-like seta per side, these distantly spaced. Cocoon slipper shaped, well formed, with straight anterior margin lacking distinct anterior collar.

Female.—Length: thorax, 1.0–1.2 mm ($\bar{x}$ = 1.1, n = 20); wing, 2.3–2.7 mm ($\bar{x}$ = 2.5, n = 20). Head gray-blue, pollinose. Frons about twice as long as broad, broadest at middle. Antennal scape and pedicel brown; flagellum with basal article yellowish brown, distal articles brown. Haustellum pale brown. Labellum brown. Mandible with 32–40 ($\bar{x}$ = 36, n = 10) serrations. Lacinia with 21–28 ($\bar{x}$ = 25, n = 10) retrorse teeth. Maxillary palpus brown. Sensory vesicle ovate, about ⅓ as long as its segment, positioned slightly proximal of middle; mouth small, centrally positioned, about ⅓ length of vesicle. Median proximal space of cibarium broadly U-shaped, with two, rounded, elevated groups of small denticles. Proepisternum and proepimeron pale brown. Postpronotal lobes pale brown. Scutum orange or dark brown-black, clothed in golden decumbent pile, and with four silvery blue longitudinal stripes; mediolateral pair of silvery blue stripes with light brown spot anteriorly and extended to concolorous posteriorly declivity; lateral pair extended along superalar region to posterior declivi-



Figs. 11–22. SEM micrographs of pupal gills. 11, *Simulium robynae* (male). 12, *S. notatum* (male). 13, *S. robynae* (female). 14, *S. notatum* (female). 15, *S. robynae* (male). 16–17, *S. trivittatum* (females). 18, *S. longithallum* (female). 19, *S. mediovittatum* (male). 20, *S. mediovittatum* (female). 21, *S. bivittatum* (female). 22, *S. venator* (female).

ty; stripe of background color (orange or brown-black) between mediolateral and lateral silvery blue stripes, when orange, usually with posteriormost portion dark brown; interface of orange or brown-black and silvery blue stripes ragged. Scutellum pale brown, with long, golden brown setae posteriorly. Anepisternum pale brown; anepisternal membrane pale brown. Katepisternum brown, with rich blue pollinosity. Mesepimeron pale brown, with golden tuft. Meron brown, with blue pollinosity. Anatergite and katatergite pale brown. Setae and spinules of basicosta golden. Setae and spinules of costa and radius brown distal to wing base. Stem vein with golden setae. Subcosta bare ventrally. Fringes of calypter and anal region pale, golden. Halter yellow, with stem pale brown. Legs bicolored, mostly pale yellowish brown with distal portions usually brown. Prothoracic leg with coxa, trochanter, femur, and tibia pale yellowish brown with golden setae; foretarsus dark brown-black, with dark brown setae. Mesothoracic leg similar to prothoracic one except coxa brown, basitarsus with proximal $\frac{5}{6}$–$\frac{4}{5}$ yellow brown, and second tarsomere with distal ½ brown. Metathoracic leg similar to prothoracic one except femur with distal $\frac{1}{5}$–$\frac{1}{4}$ brown, distal $\frac{1}{6}$–$\frac{1}{3}$ of tibia brown, and basitarsus with proximal ½ pale yellow brown. Claws simple. Abdominal segment I pale brown, fringed with long golden setae; abdominal tergite II with dark brown spot medially; abdominal tergites III–IV with dark brown median and one lateral spot per side; abdominal tergites V–VI with dark brown median and two lateral spots per side; lateral spots of tergites III–VI decreasing in size and increasing in distance from median spot posteriorly; abdominal tergites VII–IX shiny pale brown. Pleural region pale yellow brown. Genitalia: Figs. 30, 34. Genital fork with arms forming angle of approximately 90°; inner margin of proximal space with one, oval, flattened, expansion per side; anteriorly directed apodemes well sclerotized. Spermatheca ovoid, lacking noticeable sculpturing. Anal lobe with slender, anteromedially directed ventral process about ⅓ height of lobe; in ventral view, apices of anal lobes not crossed and posteromedian process digitiform. Cercus rounded.

Male.—Length: thorax, 1.0–1.2 mm ($\bar{x}$ = 1.1, n = 20); wing 2.1–2.3 mm ($\bar{x}$ = 2.2, n = 20). Not differing from female except as follows. Scutum matte black with two crescent-shaped silvery blue areas anteriorly, longitudinal silvery blue stripe along superalar region, and posterior declivity silvery blue; anterior silvery blue areas with pale brown anteromedian spot. Legs more uniformly brown. Setae of wing base (stem vein) brown. Abdomen: tergite II with circular, dark brown median spot and adjacent silvery area on each side; tergites III–V with large black rectangular spot medially; tergites V and VI each with silvery area lateral to median brown spot; tergite VI with square, dark brown median spot; tergites VII–IX each with rectangular, dark brown spot, that of tergite VII smallest. Genitalia: Figs. 39, 47, 53. Gonocoxa rectangular, slightly longer than wide. Gonostylus slightly shorter than gonocoxa, with large posterolateral flange and one stout spinule apically. Ventral plate in ventral view somewhat rectangular; plate in lateral view with arms directed upward, anterior margin slightly concave, middle of posterior margin roughly parallel to anterior margin, and lip narrowed apically and slightly upturned; plate in terminal view with lip rounded.

Lectotype—♂, slide-mounted. CALIFORNIA: (Fresno Co.), Fresno, May 12, 1923, M. E. Phillips (USNM).

Paralectotypes.—CALIFORNIA: (Fresno Co.), Fresno, 24 April 19?? (year unrecorded), A. E. Schwarz—1 ♂ (slide-mounted); Fresno, May 12 1923, M. E. Phillips—1 ♂ (slide-mounted) (USNM).

Additional material examined.—USA: CALIFORNIA: Fresno Co., Fresno, 4 June 1948, light trap, T. Raley—1 ♀; Riverdale, July 1948, T. Raley—1 ♀. (Kern Co.), Kern River Park, 1 July 1948, B. Bookman—3

♂, 1 ♀ (USNM). Bakersfield, about horses, 29 June 1959, Monji—2 ♀ (USNM). Merced Co., Snelling Ct., September 1947, Ed Smith—1 ♀; Merced River at Oakdale Rd., 18 km NW of Merced, 15 May 1993, J. K. Moulton—6 larvae, 1 ♂ & 1 ♀ w/exuviae; 19 May 1993, J. K. Moulton—6 larvae; 2 October 1993, J. K. Moulton—33 larvae, 8 pupae, 6 ♂ & 15 ♀ w/exuviae. (Riverside Co.), Riverside, 28 May 1945, A. L. Melander—3 ♀. San Joaquin Co., Mokelumne River at Bruella Rd., ca. 9 km NE of Lodi, 2 October 1993, J. K. Moulton—103 larvae, 33 pupae, 101 ♂ & 99 ♀ w/exuviae. Tulare Co., Visalia, 9 June 1969, W. D. Murray—4 ♀.

Remarks.—The series from which Dyar and Shannon (1927) described this species contained 15 adults. Of these, seven were designated as types. Four were females belonging to the subgenus *Hellichiella* (= paratypes) and three were males belonging to the subgenus *Psilopelmia* (= cotypes). The whereabouts of these females is unknown, but fortunately the males were deposited in the United States National Museum in Washington. Peterson (1993) designated one of these males as the lectotype.

This species is only known from California, where the immatures are common in medium-sized streams to large rivers. Collection data suggests this species may further be restricted to the San Joaquin Valley and southward. Trailing grasses and leaves are seemingly preferred as substrate, although rocks were the only suitable substrate at the Merced River site.

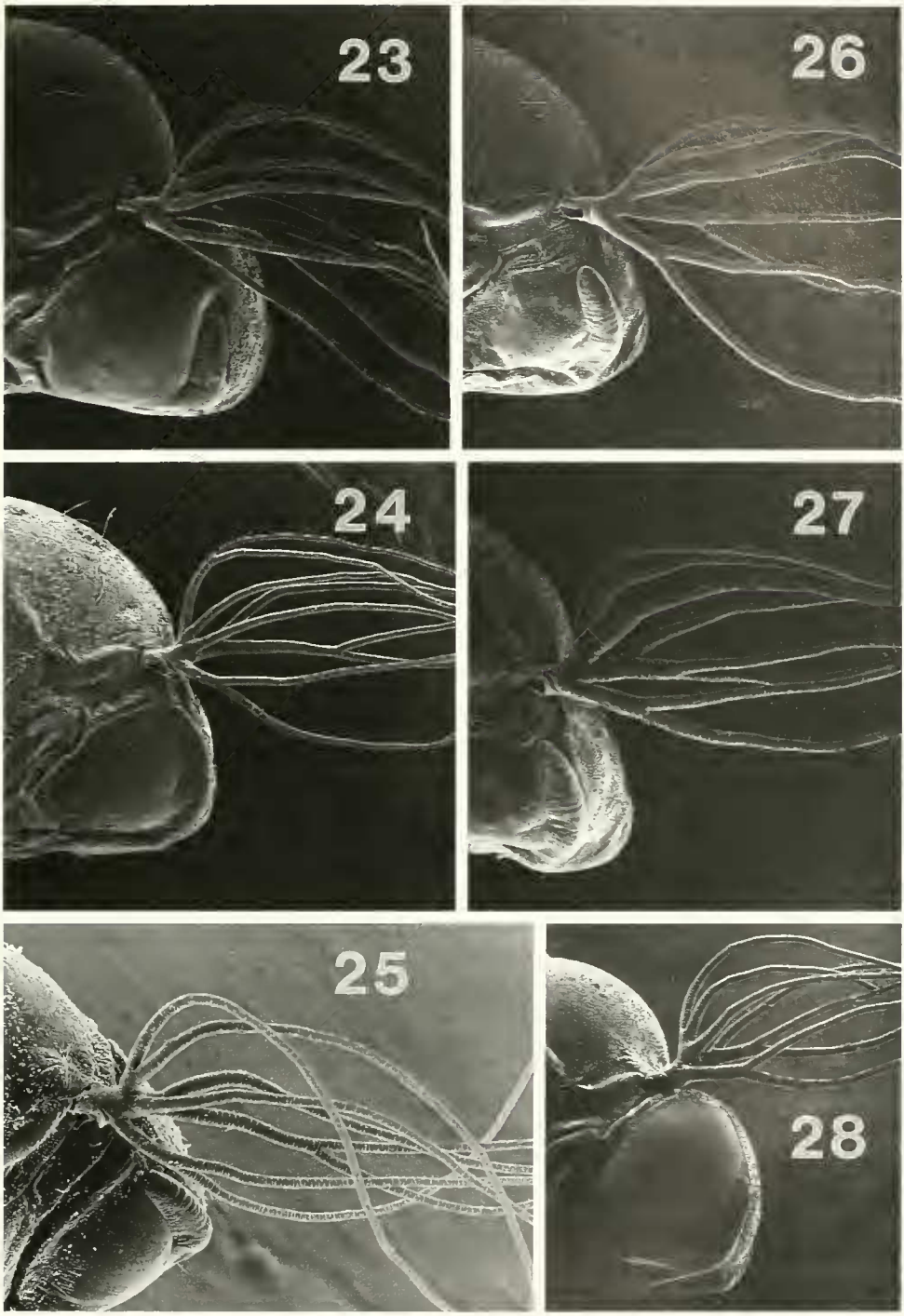
This species has been erroneously referred to as *S. trivittatum* on numerous occasions in the literature. The vast majority of these misidentifications are based upon field-collected females. The female scutum is variable in color and, depending upon the degree of darkness, resembles those of *S. bivittatum, S. longithallum,* and *S. trivittatum.* The latter two species are easily separated from *S. bivittatum* and *S. clarum* by terminalia characters. Orange females of *S. clarum* have blue scutal stripes whereas those of typical *S. bivittatum* have white stripes. Dark females of both species have blue stripes. Although I can find no obvious way to distinguish individual females of *S. clarum* from those of *S. bivittatum* with confidence, the key to females allows tentative separation based upon scutal coloration and geographic location of the specimens. Collections in California, and possibly Oregon, in which dark-colored females abound are at least predominately of this species.

The male closely resembles that of *S. bivittatum,* but differs slightly in several aspects as mentioned in the following key; males of this species, unlike *S. bivittatum,* were not observed to have orange scutum variants. This species is the only one in the subgenus with a gill of nine or ten filaments, although individuals with eight filaments are occasionally encountered. No other species treated in this work has strictly green and gray larvae when fixed in Carnoy's solution. The gray larvae typically have darker infuscation of the posterior half of the cephalic apotome than do the greenish ones. This color variation is not absolutely attributable to sexual dimorphism, although most gray larvae are males. Some, but not all, larvae have a distinct brown border surrounding the postgenal cleft.

Simulium (Psilopelmia) griseum Coquillett

Simulium griseum is widespread in lowland areas throughout most of the western United States and the prairie of Canada (Peterson 1993), where it is occasionally a pest of humans and large mammals (MacNay 1952, 1958; Undeen 1973; Jones et al. 1977). D. G. Mead (pers. comm.) observed numerous females of this species biting his ankles between 4:00 and 5:30 PM in Trail Canyon, Montezuma County, Colorado, on 11–12 August 1996.

The immature stages generally occur in siltier watercourses than other species in the subgenus and irrigation ditches are a typical habitat. All life stages after the egg resemble those of *S. notatum,* with only males



Figs. 23–28. SEM micrographs of pupal gills. 23–25, *Simulium clarum* (male, female, female). 26–28, *S. notatum* (female, female, male).

and, to a lesser extent, larvae being separable with confidence. Practically all larvae in the lone available collection of Carnoy's-fixed material of this species were creamy white; a few were very pale whitish green or gray. This is not the case for any other species of *Psilopelmia* treated herein except *S. robynae,* which also is represented by a single, though large collection. Similarly preserved larvae of *S. griseum* are needed from across its considerable range before the utility of this character can be fully ascertained.

Although females of this species and *S. notatum* are inseparable, I tentatively accept all southern California records of grayish green colored *Psilopelmia* females as being *S. griseum* since males of this species have been confirmed from there. This region is the most likely place where these species may be sympatric.

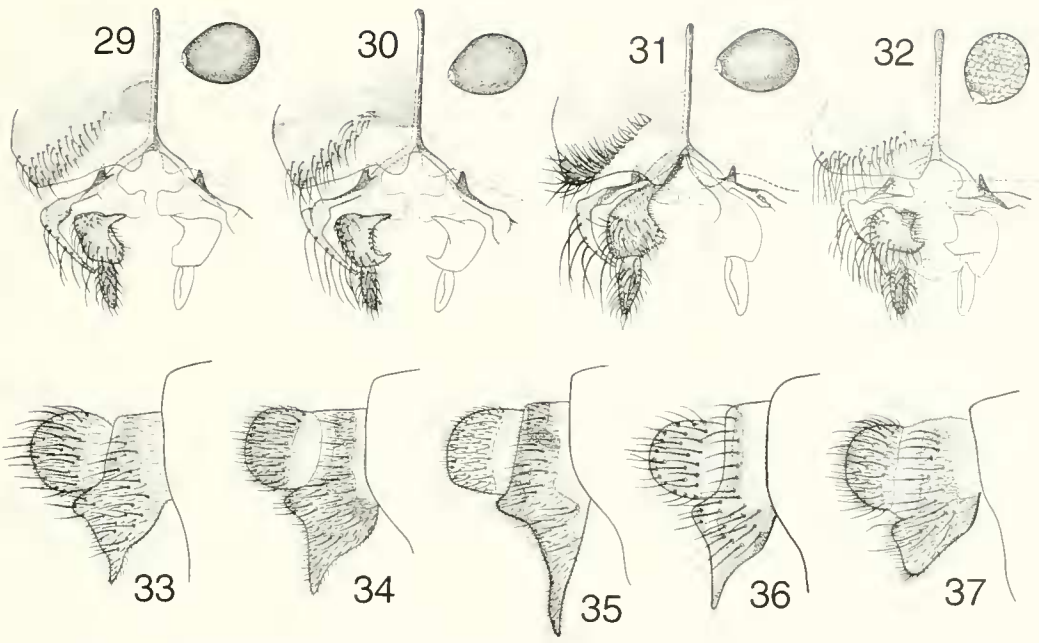
The male ventral plate of *S. griseum* as rendered in Figures 25a and 299a in Peterson (1993) and Peterson and Kondratieff (1995), respectively, is atypical in that it is more squared than normal, which makes it look much like that of *S. venator.* The illustrations of the female terminalia in ventral view, Figures 26a and 300a in Peterson (1993) and Peterson and Kondratieff (1995), respectively, may not be those of *S. griseum* and are possibly those of either *S. bivittatum* or *S. clarum*; this hypothesis is based upon the pointed rather than squared posteromedian process of the anal lobe that characterizes females of this species and *S. notatum.* Unfortunately, the terminalia of the holotype female of *S. griseum* are missing and presumed lost (Holly Williams, personal communication).

Material examined.—CANADA: ALBERTA: Milk River, 4 July 1964, G. C. & D. M. Wood—13 ♂ & 14 ♀ w/exuviae (CNC). USA: CALIFORNIA: Imperial Co., Palo Verde, 8 April 1949, W. W. Wirth—1 ♀ (USNM); Laguna Lake, 10 June 1950, J. N. Belkin—2 ♀ (USNM). Riverside Co., Blythe, 1 May 1947, A. L. Melander—1 ♀ (USNM). Blythe, 20 May 1950—2 ♂, 3 ♀ (USNM). San Bernadino Co., Vidal, light trap, April 1948, R. W. Coleman—3 ♀ (USNM). NEW MEXICO: (Dona Ana Co.) Las Cruces, 12 June 1950, R. H. Beamer—1 ♀ (USNM); Las Cruces, 12 August 1962, C. P. Hibler—1 ♀ (USNM); Radium Hot Springs, Las Cruces, ex. horse, 29 July 1972, USDA—1 ♀ (USNM). Rio Grande at Rt. 28, ca. 10km S of Las Cruces, 16 March 1993, J. K. Moulton—58 larvae, 1 pupa. Taos Co., Rio Grande, 6 July 1953, W. W. Wirth—1 ♀ (USNM). Valencia Co., irrigation canal off of Rio Grande River near Los Lunas, 7 June 1995, J. K. Moulton—25 larvae, 30 ♂ & 22 ♀; ex. horses, 8 June 1995, M. Schmidtmann, G. Hunt, D. Mead, J. K. Moulton—18 ♀. UTAH: (Daggett Co.), Manilla, 5 September 1939, G. F. Knowlton & F. C. Harmston—1 ♀ (USNM). Duchesne Co., Myton, 2 July 1963, G. C. & D. M. Wood—1 ♂ & 3 ♀ w/exuviae (CNC). (San Juan Co.), San Juan River, Bluff, 30 August 1942, G. F. Knowlton—2 ♀ (USNM). (Sevier Co.), Richfield, 21 September 1929, David E Fox—1 ♀ (USNM). Elsinore, 5 October 1929, David E. Fox—1 ♀ (USNM).

Simulium (*Psilopelmia*) *labellei* Peterson

Mature larvae are tentatively separable from other species treated herein by the number of hooklet rows in the posterior proleg (>110 rows versus <100 rows in the other species). Pupae can be confused only with those of *S. robynae,* which also have an exaggerated angle at the cephalothoracic junction. Slight chaetotaxonomic differences allow separation of these closely related, sympatric species. The adults are separated from *S. robynae* by their larger size and gray, rather than orange-brown, scutum. No significant genitalic differences were detected between this species and *S. robynae.* This species is apparently restricted to southernmost Texas and adjacent Mexico. It possibly undergoes a single generation during mid-winter, as material is only known from December through April.

Material examined.—USA: TEXAS:



Figs. 29–37. Female terminalia (29–32 = terminalia in ventral view; 33–37 = right anal lobe and cercus in lateral view). 29, *Simulium notatum*. 30, *S. clarum*. 31, *S. longithallum*. 32, *S. mediovittatum*. 33, *S. notatum*. 34, *S. clarum*. 35, *S. longithallum*. 36, *S. venator*. 37, *S. mediovittatum*.

Presidio Co., Presidio, 12 January 1949—3 ♂, 4 ♀ (paratypes); Presidio, 12 January 1944, 1 ♂ (paratype). MEXICO: 13 January 1940—1 ♂ (paratype).

Simulium (*Psilopelmia*) *longithallum* Díaz Nájera and Vulcano
(Figs. 3, 4, 9, 18, 31, 35, 40, 45, 49, 55)

Larva.—Length 4.3–5.8 mm ($\bar{x}$ = 5.2, n = 20). Not differing from that of *S. clarum* except as follows. Body coloration variable, ranging from pale green, gray, purple, to reddish brown with pale whitish, intersegmental areas. Head capsule (Figs. 3, 4) pale brown. Frontoclypeal apotome with varying amounts and degrees of infuscation posteriorly, contrasting sharply from pale whitish yellow headspots. Antenna mostly dark brown, noticeably darker than stalk of labral fan; segment I pale yellowish brown; segment II dark brown except for distal end; segment III entirely dark brown. Labral fan with 32-36 primary rays ($\bar{x}$ = 32, n = 20). Area between hypostoma and postgenal bridge (as in Fig. 4) noticeably paler than surrounding portion of head capsule, forming an oval to round spot. Posterior proleg bearing 10–13 hooks in 67–73 rows.

Pupa (Fig. 9).—Length 2.3–3.4 mm ($\bar{x}$ = 2.8, n = 20). Not differing from that of *S. clarum* except as follows. Gill (Fig. 18) 0.9–1.25 times length of pupa, comprised of 8 filaments branching 2+1, 2+1, 1+1; dorsal two groups of three filaments branching distal to gill base on swollen petiole approximately 2.5–3.0 times diameter of ventral petiole bearing two filaments.

Female.—Length: thorax, 0.9–1.2 mm ($\bar{x}$ = 1.0, n = 20); wing, 2.0–2.8 mm ($\bar{x}$ = 2.5, n = 20). Not differing from that of *S. clarum* except as follows. Mandible with 32–44 ($\bar{x}$ = 38, n = 10) serrations. Lacinia with 21–27 ($\bar{x}$ = 23, n = 10) retrorse teeth. Scutum orange-brown to dark brown-black, clothed with golden decumbent pile, and with four longitudinal silvery blue (rarely silvery yellow) stripes extended length of

scutum forming a median and a pair of mediolateral stripes of orange-black; one pair of longitudinal silvery blue stripes bordering the superalar region; the other pair separating median and mediolateral stripes; mediolateral stripes reaching posterior declivity; median stripe not reaching posterior declivity. Scutellum pale yellow brown, with long, golden setae posteriorly. Anepisternum and anepimeron brown, with faint blue pollinosity. Katepisternum and katepimeron dark brown, with faint blue pollinosity. Meron brown, with faint blue pollinosity. Prothoracic tibia with distal 1/5 dark brown with brown setae. Abdominal tergite II with dark brown median spot and one faint brown dorsolateral spot per side; abdominal tergites III–VI with dark brown median spot and 2 accompanying dorsolateral spots per side, lateralmost dorsolateral spot smaller than the other; abdominal tergite VII with 2 dorsolateral spots per side. Abdominal dorsum and pleural region clothed with brown setae. Genitalia: Figs. 31, 35. Anal lobe with slender, ventral, digitifom process that is as long as height of lobe; apices of lobes crossed in ventral view.

Male.—Length: thorax, 0.9–1.1 mm ($\bar{x}$ = 0.9, n = 20); wing 2.0–2.6 mm ($\bar{x}$ = 2.3, n = 20). Not differing from female except as follows. Scutum with black stripes slightly wider than silvery blue stripes. Prothoracic leg with distal ¼ of tibia dark brown. Meso- and metathoracic thoracic legs with trochanter brown. Metathoracic leg with femur almost entirely brown and tibia with distal ½ brown. Genitalia: Figs. 40, 45, 49, 55. Gonostylus with large posterolateral flange. Ventral plate in ventral view somewhat squared, with prominent, anteriorly directed flange; plate in lateral view with prominent, gently sloped anterior margin (lip) and nearly vertical posterior margin; plate in terminal view with lip roughly triangular.

Material examined.—USA: ARIZONA: Cochise Co., San Pedro River at Rt. 90, 6 May 1991, C. A. Olson—1 larva; 17 January 1992, E. W. Cupp & F. Ramberg—3 pupae, 1 ♀ w/exuviae; 2 February 1992, E. W. Cupp & F. Ramberg—2 exuviae; 14 June 1992, J. K. Moulton—1 ♂ w/exuviae; 14 November 1992, J. K. Moulton and D. G. Mead—117 larvae, 19 pupae, 12 ♂ & 18 ♀ w/exuviae; 28 April 1993, J. K. Moulton—3 larvae. Gila Co., Coon Creek at Cherry Creek Rd. off Rt. 388, 13 May 1993, J. K. Moulton—436 larvae, 36 pupae, 44 ♂ & 37 ♀ w/exuviae.

Remarks.—This species is closely related to a host of other species in the group, especially *S. escomeli* Roubaud, *S. gonzalezherrejoni* Díaz Nájera, and *S. trivittatum* Malloch. These species are characterized by the dark antennae of the larva, the long ventral projection of the female anal lobe, and the pronounced anterodorsal flange of the ventral plate and posterolateral flange on the gonostylus of the male. On the basis of the unique structure of the pupal gill, the sister species of *S. longithallum* is *S. gonzalezherrejoni*.

Previously, this species was known only from Morales and Guadalahara, Mexico (Díaz Nájera and Vulcano 1961; Coscarón et al. 1995). It is now known from two streams in the United States, the San Pedro River and Coon Creek, which are located in the southeastern and eastcentral portions of Arizona, respectively. The San Pedro River is moderately fast flowing, has a bottom of sand and silt and trailing green vegetation, and is approximately 2–5 m in width and 0.5 m in depth, except following periods of heavy rain. Coon Creek is slightly narrower and shallower, is strewn with rocks, and has little trailing green vegetation.

Large numbers of immatures of this species occur in the San Pedro River by November, when it is the dominant simuliid species. The population remains fairly stable through February, but by April or May it dwindles considerably. During the heat of late summer and early autumn, typically June through October, this species all but disappears from the San Pedro River. This

phenomenon also appears to occur in Coon Creek although not as pronounced. The immatures seem to prefer trailing green vegetation as substrate but will attach to sticks and rocks. This species probably overwinters as eggs or larvae in Coon Creek but apparently has continuous development through the winter in the San Pedro River.

Simulium (*Psilopelmia*) *mediovittatum* Knab
(Figs. 19, 20, 32, 37, 43, 51, 57)

Simulium mediovittatum is most closely related to *S. dugesi* and *S. ochoai,* neither of which have not been reported north of Mexico. The pupa of *S. mediovittatum* is separated from those of species treated in this work with similarly shaped gills by the middle group of gill filaments branching 2+1 rather than 1+2. The female is immediately separated from all North American species by the light gray scutum with its median red-brown to black stripe. The male is separated from all other species with a predominantly black scutum by the silvery blue stripes tapering much more dramatically as they meet the posterior declivity. This species is not known to occur anywhere in the United States other than southcentral Texas.

Material examined.—TEXAS: Kinney Co., Pinto Creek at US Rt. 90, E of Del Rio, 18 March 1992, J. K. Moulton—7 larvae, 9 pupae, 6 ♂ and 14 ♀ w/exuviae.

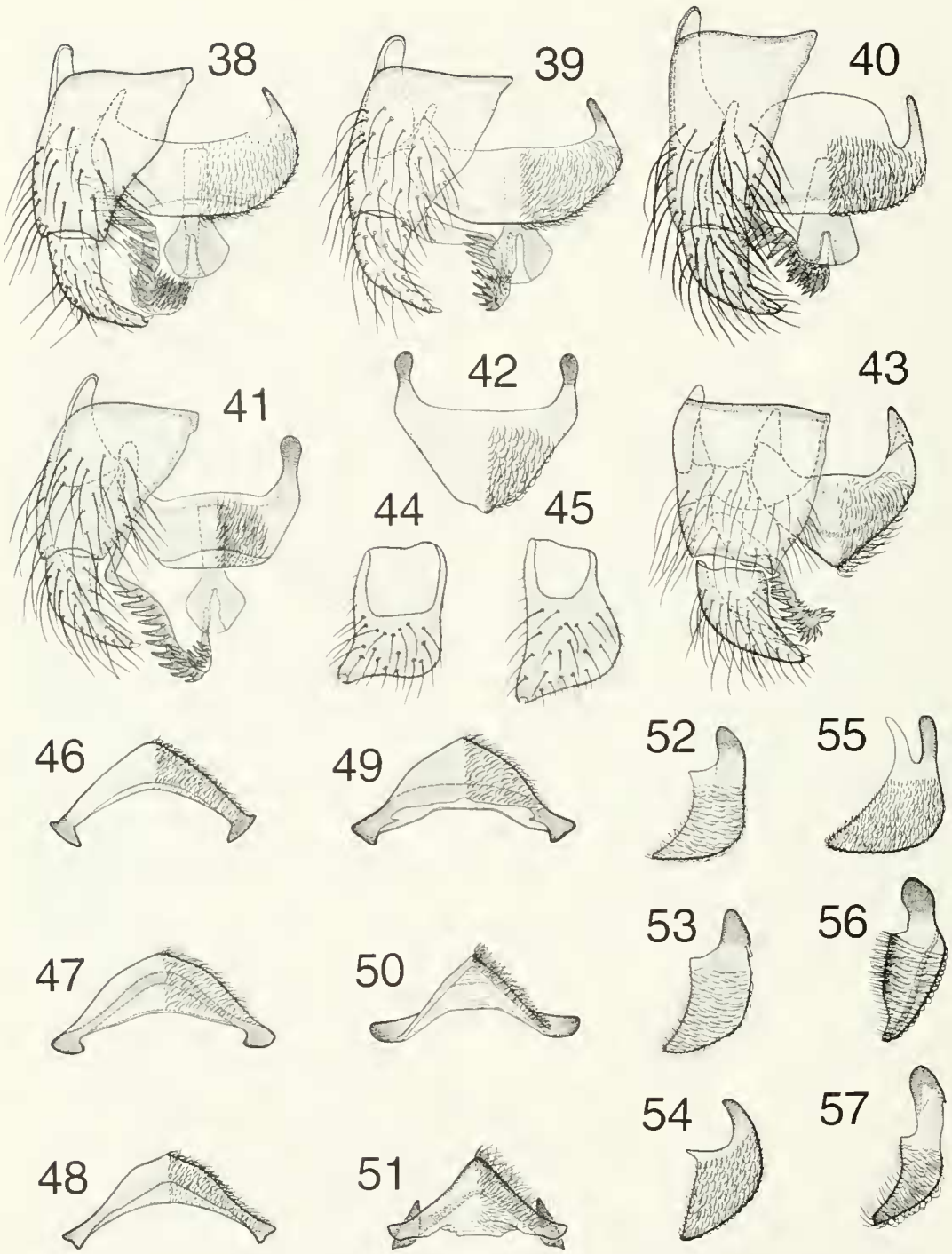
Simulium (*Psilopelmia*) *notatum* Adams
(Figs. 5, 6, 10, 26–28, 29, 33, 38, 44, 46, 52)

Simulium (*Psilopelmia*) *griseum* Peterson 1993: 34 (*nec* Malloch 1914), in part (AZ records)

Larva.—Length 4.3–5.5 mm ($\bar{x}$ = 5.0, n = 20). Not differing from that of *S. clarum* except as follows. Body coloration variable, ranging from pale green, gray, purple, to reddish brown with distinct, pale whitish intersegmental areas. Testes of male dark, clearly evident through integument. Headspot pattern (Fig. 5) negative, usually very faint; sometimes only discernible infuscation a pair of semicircular spots immediately adjacent to area between anteromedian and posteromedian headspots. Labral fan with 48–55 primary rays ($\bar{x}$ = 52, n = 20). Postgenal cleft (Fig. 6) oval, sometimes slightly pointed apically, and extended ⅓ distance to hypostomal groove; width of postgenal cleft variable, ranging from about as wide as long to 1.3 times longer than broad. Posterior proleg bearing 11–15 hooks in 75–82 rows.

Pupa (Fig. 10).—Length 2.3–2.8 mm ($\bar{x}$ = 2.5, n = 20). Not differing from that of *S. clarum* except as follows. Gill (Figs. 26–28) ⅔–¾ length of pupa, comprised of eight filaments branching 2+1, 1+2, 1+1; dorsalmost pair of filaments arising from short petiole, not widely separated from lone filament arising at their base; median group of filament comprised of a strongly arched dorsal filament usually hidden behind proximal filament of dorsal trio and that arises basally from a petiolate pair that bifurcate approximately at midlength of gill; petiole of median pair of filaments distal to lone filament slightly sinuous and directed anteriorly or only slightly downward; ventral pair of filaments branching along proximal ⅛ of gill's length. Abdominal tergite II with 5–6 strong, distinctly noticeable setae per side.

Female.—Length: thorax, 0.9–1.2 mm ($\bar{x}$ = 1.1, n = 20); wing, 2.1–2.6 mm ($\bar{x}$ = 2.4, n = 20). Not differing from that of *S. clarum* except as follows. Mandible with 38–45 ($\bar{x}$ = 40, n = 10) serrations. Lacinia with 24–28 ($\bar{x}$ = 26, n = 10) retrorse teeth. Scutum color variable, ranging from bright orange to orange-brown with two thin, pale white longitudinal, stripes on either side of orange-brown median stripe that is slightly darkened anteriorly to gray with two thin, pale beige longitudinal stripes on either side of dark brown-black median stripe; scutum clothed in golden decumbent pile; anteriormost portion of scutum medial to postpronotal lobes pale brown, continuing as



Figs. 38–57. Male terminalia (38–41, 43 = ventral view, left gonostylus removed; 44–45 = right gonostylus, dorsal view; 46–51 = ventral plate in terminal view; 52–57 = ventral plate in lateral view). 38, *Simulium notatum*. 39, *S. clarum*. 40, *S. longithallum*. 41, *S. venator*. 42, *S. venator* (ventral plate alone). 43, *S. mediovittatum*. 44, *S. bivittatum*. 45, *S. longithallum*. 46, *S. notatum*. 47, *S. clarum*. 48, *S. bivittatum*. 49, *S. longithallum*. 50, *S. venator*. 51, *S. mediovittatum*. 52, *S. notatum*. 53, *S. clarum*. 54, *S. bivittatum*. 55, *S. longithallum*. 56, *S. venator*. 57, *S. mediovittatum*.

stripe that borders superalar area along entire length of scutum. Scutellum with long, golden setae posteriorly. Mesothoracic tarsomeres with distal ⅓ brown. Metathoracic femur with distal ⅕–¼ brown. Genitalia: Figs. 29, 33. Anal lobe in ventral view with posteromedian process squared.

Male.—Length: thorax, 0.8–1.1 mm ($\bar{x}$ = 1.0, n = 20); wing, 1.8–2.5 mm ($\bar{x}$ = 2.2, n = 20). Not differing from that of *S. clarum* except as follows: Scutum matte black (rarely orange), bordered laterally and posteriorly with iridescent silvery blue; black area with pair of large, anterior, triangular, iridescent coppery blue-green areas that are broadly contiguous anteriorly with iridescent lateral areas and extended to just short of posterior declivity. Genitalia: Figs. 38, 44, 46, 52. Ventral plate roughly rectangular: plate in lateral view with anterior margin moderately concave and lip narrowed terminally; lip in terminal view inverted V-shape with blunt apex.

Material examined.—USA: ARIZONA: Cochise Co., San Pedro River at Rt. 80 near St. David, 21 November 1992, J. K. Moulton—2 larvae, 2, pupae, 1 ♂ & 2 ♀ w/exuviae; SPR at Rt. 90, ca. 14 km east of Sierra Vista, 28 April 1993, J. K. Moulton—numerous larvae (mixed with *S. bivittatum*), 12 pupae, 55 ♂ & 67 ♀ w/exuviae. Gila Co., San Carlos River at Rt. 103, ca. 2 km NE of Peridot, 5 September 1992, J. K. Moulton—133 larvae, 52 pupae, 32 ♂ & 30 ♀ w/exuviae. Coolidge Dam Area, 3 December 1937, C. C. Deonier—4 ♀ (USNM). Pinal Co., Aravaipa Creek at Aravaipa Rd., 11 July 1993, J. K. Moulton—497 larvae, 9 pupae; 18 October 1992, J. K. Moulton—173 larvae; Gila River at Winkleman, 5 September 1992, J. K. Moulton—78 larvae, 25 pupae, 37 ♂ & 43 ♀ w/exuviae. Santa Cruz Co., Nogales, no host trap, 10 March 1961, Allen—1 ♀ (USNM). Yavapai Co., Santa Maria River at Rt. 93, July 1993, J. K. Moulton—213 larvae, 27 pupae, 57 ♂ & 54 ♀ w/exuviae.

Remarks.—*Simulium notatum* is a common species in small to large, fast flowing streams and rivers of southern Arizona. It is probable that *S. notatum* ranges into northern Mexico. The immatures seem to prefer trailing vegetation for substrate, but rocks are used when such substrate is lacking. The Gila River at Winkleman, San Carlos River near Peridot, and Aravaipa Creek near the Aravaipa Canyon Wilderness Area, are nearly pure populations *S. notatum*, with *S. bivittatum* a rare cohabitant. Further upstream in the Gila River, however, in Catron County, New Mexico, *S. bivittatum* is the only species of *Psilopelmia* present. *Simulium argus* and *S. encisoi* are the other dominant simuliids in these streams. Aravaipa Creek is the opposite to the Gila River in that *S. notatum* is practically the only species of *Psilopelmia* in the upper reaches of the stream, whereas *S. bivittatum* is the dominant species in the lower reaches.

The immatures are creamy green-gray or red banded in the field and when freshly fixed, but many become brilliant purple with thin intersegmental areas after 2–3 weeks in Carnoy's solution. Larvae have a variable, negative headspot pattern and cannot be separated from those of several species unless mature. The pupa is separable from that of *S. bivittatum*, the only consubgeneric species with which it is known to be associated, by the structure of the gill. If additional collecting demonstrates association with *S. griseum* (most likely in eastern CA or western NM) then these pupae will not be separable.

Simulium notatum most closely resembles *S. griseum*, which was evident to Adams (1904) when he described it. The colors of the male scutum are consistently different from those of *S. griseum*, although the underlying pattern is very similar. Occasionally, the typically black median stripe of males of *S. notatum* is orange. Males of *S. venator* also sometimes have a wide orange median stripe, but the areas lateral to it are black rather than iridescent coppery blue-green as in *S. notatum*. Greased males of *S. notatum* superficially resemble those of *S. venator*, but these specimens can eas-

ily be separated using the ventral plate. The terminalia of both sexes of *S. notatum* and *S. griseum* are inseparable. When fixed in Carnoy's solution, larvae of *S. notatum* range from green to brilliant purple, whereas those of a nearly sympatric population of *S. griseum* are pale, creamy white. Mature larvae of *S. notatum* have 75–83 rows of hooklets in the posterior proleg, whereas those of *S. griseum* have fewer than 60 (Peterson 1993). Females and pupae of *S. notatum* are inseparable from those of *S. griseum*. Very cursory cytological observations show differences among the two species (P. H. Adler, pers. comm.), however, the samples were small and the populations geographically disjunct. Directed heteroduplex analysis using partial mitochondrial gene sequences (Tang et al. 1997) and partial nucleotide sequences of ND4 (K. Pruess, in litt.) from several related species of *Psilopelmia* clearly differentiate *S. notatum* and *S. griseum*. Based upon these differences, *S. notatum* is recognized as a valid species. Nothing is known about the feeding habits of females of this species other than presumably they are not frequent human biters.

Simulium (*Psilopelmia*) *robynae* Peterson
(Figs. 11, 13, 15)

The sharp angle of the cephalothoracic region and exaggerated, humpbacked scutum separates the pupa and adults, respectively, from all others except those of *S. labellei*. Pupae of the two species can be separated by slight chaetotaxonomic features. The adults of *S. robynae* are orange to brown whereas those of *S. labellei* are gray.

This species breeds in the lower reaches of the Rio Grande River system of Texas and adjacent Mexico. Large numbers of larvae and pupae were found on trailing vegetation and filamentous algae in the Rio Grande River in March 1993. In 1895, large numbers of females of this species were observed attacking a horse in the Mesilla Valley of New Mexico (Cockerell 1897). No other incidents of this nature had been or have been reported since.

Material examined.—USA: TEXAS: Brewster Co., Rio Grande at Big Bend National Park nr. Hot Springs area, 17 March 1993, J. K. Moulton—123 larvae, 31 pupae, 16 ♂ & 27 ♀ w/exuviae.

Simulium (*Psilopelmia*) *trivittatum*
Malloch
(Figs. 16, 17)

The larva of this species is separable from those of all other North American relatives, except *S. longithallum*, by the dark antennae. The region between the postgenal cleft and hypostoma is concolorous with the remainder of the head capsule in this species, whereas it is notably paler in larvae of *S. longithallum*. Pupae of this species typically have gills of 6 filaments, but individuals with 7 and 8 filaments are not uncommon. It is quite possible *S. bobpetersoni* Coscaron, Ibanez-Bernal, and Coscaron-Arias is synonymous with *S. trivittatum*, and the difference in gill filament number, 8 versus 6, which is one of the primary differences between the two forms, represents a cline in which southern populations have a greater number of individuals with eight-filamented gills.

The distribution of *S. trivittatum* is more restricted than previously thought. The Arizona records are based upon males of *S. argus*, and the California records are based upon males of *S. argus* and males and females of *S. clarum*. At least one of the New Mexico records (Catron County) listed in Peterson (1993) is also based on males of *S. argus*. Since all life stages after the egg were present in the collection from Eddy County, this record is considered valid. The Oklahoma record listed in Peterson (1993) remains unconfirmed, but *S. trivittatum* is known from the Honey Creek area (Reisen 1974, 1975a, 1975b, 1977). This species is not as serious of a pest as the literature would indicate because all such reports actually refer to *S. clarum*.

Material examined.—USA: TEXAS:

Kinney Co., Pinto Creek at US Rt. 90, E of Del Rio, 18 March 1993, J. K. Moulton—77 larvae. 500+ pupae (89 w/7 filaments, 60 w/8 filaments), 200+ ♂ & 200+ ♀ w/exuviae.

Additional material examined (= misidentifications of *Simulium* (*Psilozia*) *argus* Williston).—ARIZONA: (Cochise Co.), S. W. Res. Sta., 5 mi SW of Portal, 5400 ft., Malaise trap, June 1967, C. W. Sabrosky—2 ♂ (USNM). (Pinal Co.), Superior, 13 April 1935, A. L. Melander—2 ♂ (USNM). NEW MEXICO: Catron Co., Whitewater Cyn., Malaise trap, 1 June 1972, W. W. Wirth—3 ♂ (USNM).

Simulium (*Psilopelmia*) *venator*
Dyar and Shannon
(Figs. 22, 36, 41, 42, 50, 56)

The larva of this species is not reliably separated from those of other species treated herein. The pupa most closely resembles that of *S. bivittatum* in that the petiolate pair in the middle group of gill filaments is directed anterodorsally, but a subtle difference in the thickness of the petiole of the dorsal group of filaments provides a means for their separation. Females are easily separated from those of all other species by the median stripe of the scutum and prominent, ventrally directed projection of the anal lobe.

The vast majority of females of *Simulium venator* from west of the Sierra Nevada Mountains have a black median stripe, whereas most of those from east of there have an orange median stripe. When orange-striped females are cleared in hot lactic acid, the underlying cuticle is lightly colored and a pair of widely separated dark stripes are evident. When black-striped females are cleared, three dark stripes are evident. Other than these correlated characters, I cannot find any significant differences between these populations. Without more convincing evidence, I hesitate to recognize more than a single species here especially since the type specimens of both *S. beameri* and *S. venator* are black-striped females. The median stripe of female *S. mediovittatum* also varies from red-orange to brown-black. The sparse number of reports indicate this species is not serious pest.

Males are similar to those of *S. bivittatum* and *S. clarum*, but the silvery blue markings on the scutum are longer in the latter species and their ventral plates noticeably more rectangular. The ventral plate of *S. venator* varies considerably when viewed ventrally. When the ventral lip is tilted dorsally (Fig. 41), the plate appears somewhat squared, whereas when directed ventrally (Fig. 42), the plate has a pronounced truncate anterior margin with a small, terminal nipple-like projection. Figure 76a in Peterson (1993) and Figure 315a in Peterson and Kondratieff (1995) is intermediate on the continuum between these two extremes. Figures 76b and 315b in Peterson (1993) and Peterson and Kondratieff (1995), respectively, do not clearly show the concavity just anterior (towards the ventral plate arms) to the apex of the ventral lip, a diagnostic feature of the ventral plate of this species when this structure is viewed laterally.

Material examined.—USA: CALIFORNIA: Inyo Co., Cottonwood Creek, 29 May 1970, C. L. Hogue—20 ♀, 12 ♂ (LACM). Glacier Lodge, 10 June 1968, S. M. Hogue & R. L. Penrose—13 ♀. Lone Pine Creek, 30 May 1963, Eric Fisher - 20 ♀ (LACM). Saline Valley, Salt Lake, 1060′, site 7, 1 July 1976, D. Giuliani—1 ♂ (LACM). Near Owens Lake, swarm on car at dusk, 9 July 1984, Dave Heyward—3 ♂ (USNM). San Bernadino Co., Sp. [Spring] Valley Lake, 4 mi. SE of Victorville, 4 May 1977, L. A. Lacey—1 ♀ (USNM). IDAHO: Elmore Co., Glenns Ferry, 10 May 1933, David E. Fox—7 ♀ (UID). 7 mi S of Sunnyside, 18 July 1967, L. S. Hawkins, Jr.—2 ♂ (UID). Franklin Co., Dayton Cyn., 16 June 1970—6 ♀ (UID); Treasureton Res., 17 June 1970, W. F. Barr—1 ♂ (UID). Gooding Co., 5 mi SW of Tuttle, 18 July 1957, R. A. Mackie—1 ♂ (UID); 6.5 mi. N of Gooding, 8 September 1964, W. F. Barr—1 ♂ (UID); 6

mi. E of Gooding, 11 June 1974, J. K. Wangberg—3 ♀. Owyhee Co., 5 mi. N of Murphy, 4 August 1955, W. F. Barr—1 ♀ (UID); Indian Cove, 13 September 1965, A. R. Gitting—4 ♂ (UID). (Twin Falls Co.), Twin Falls, wind vane trap, pole 27, trap 3, 9 September 1932—1 ♀ (UID). Castleford, 16 July 1929, Beets—1 ♀ (UID). (Washington Co.), Weiser, 2 September 1940, F. C. Harmston—1 ♀ (CNC). NEVADA: Elko Co., Elko, 27 June 1983, R. C. Bechtel—1 ♀ (UID). Humboldt Co., Golconda, 2 July 1963, R. C. Bechtel—1 ♀ (UID); Golconda, CO2-octanol trap 2, 12–13 July 1995, R. Gray—48 ♀. Winnemucca 31 May 1958, T. R. Haig—2 ♂ (USNM); 5 mi N of Winnemucca, 11 June 1976—2 ♀ (USNM). Lander Co., Battle Mtn., Muleshoe Bridge, 12 August 1995, R. D. Gray—17 larvae, 9 pupae. (Washoe Co.), Reno, 7 October 1915, H. G. Dyar—1 ♀ (USNM); 7 July 1916, H. G. Dyar—1 ♀ (holotype). OREGON: Baker Co., Dixie, 2 September 1940, F. C. Harmston—8 ♂, 4 ♀ (USNM). Snake River above Huntington, 13 December 1946, J. E. Davies—2 ♂, 1 ♀; 10 mi. S of Huntingdon, 12 September 1949, J. E. Davies—3 ♂, 3 ♀ (USNM). UTAH: (Cache Co.), Richmond, 13 June 1958, Keith C. Tilley—1 ♀ (CNC). Grand Co., Harley Dome, 13 August 1958, W. L. Nutting—1 ♀, 2 ♂ (UAZ). WYOMING: (Sublette Co.), Pinedale, W. L. Jellison—2 ♀ (USNM).

Keys to Species of *Simulium* (*Psilopelmia*) of America North of Mexico

Pupae

1. Head and anterodorsum of thorax disjunct, their intersection forming an angle of nearly 90 degrees (Figs. 11, 13, 15) 2
– Head and anterodorsum of thorax more continuous, gradually sloping in lateral view (Figs. 12, 14) 3
2. Thorax with a multibranched trichome just posterior to base of respiratory organ and 2 fan-like (more than 6 rays) and 1–3 simple trichomes per side anteriorly . . . . . *labellei*
– Thorax without multibranched trichome just posterior to base of respiratory organ; anterior row of multibranched trichomes with 5 or fewer branches . . . . . *robynae*
3. Gill of 6 (rarely 7 or 8) filaments, with middle pair or trio of filaments arising from long petiole (Figs. 16, 17) . . . . . *trivittatum*
– Gill of 8–10 filaments, with middle trio of filaments arising from short petiole (Figs. 11–15, 18–28) 4
4. Dorsal and median groups of filaments arising from long, swollen trunk that is at least twice width of ventral petiole (Fig. 18) . . . *longithallum*
– Dorsal and median groups of filaments not arising from swollen trunk (Figs. 11–17, 19–28) 5
5. Median group of filaments branching 2+1 (Figs. 19, 20) . . . . . *mediovittatum*
– Median group of filaments branching 1+2 or 2+2 (Figs. 11–15, 21–28) 6
6. Gill of 8 filaments; middle group of filaments with petiolate pair directed anteroventrally (Figs. 21, 22) 7
– Gill of 8–10 filaments; middle group of filaments with petiolate pair (lower pair if 2+2) directed anteriorly (Figs. 23–28) 8
7. Gill filaments, especially the dorsalmost group, slightly swollen basally; middle group of filaments with proximal filament directed anteriorly (Fig. 21) . . . . . *bivittatum*
– Gill filaments consistently thin in diameter; middle group of filaments with proximal filament usually slightly arched anterodorsally (Fig. 22) . . . . . *venator*
8. Gill of 8–10 (usually 9 or 10) filaments (Figs. 23–25); tergite II with weakly sclerotized, pale setae. Known only from CA . . . . . *clarum*
– Gill of 8 filaments (Figs. 26–28); tergite II with strong dark setae. Widespread in W Nearctic (combined distribution) . . . . . *griseum, notatum*

Females

1. Thorax, in lateral view, strongly arched, its anterior face nearly perpendicular to top of head (Figs. 110, 112 in Peterson 1993). . . . 2
– Thorax, in lateral view, not strongly arched, its anterior face forming an obtuse angle with top of head 3
2. Scutum orange-brown or at least trimmed with orange-brown . . . . . *robynae*
– Scutum entirely dark gray-black . . . . . *labellei*
3. Scutum lacking well defined stripes, varying from dull yellowish-orange with very thin, pale beige longitudinal stripes to gray with faintly visible brown to dull black median stripe anteriorly. Anal lobe in ventral view with postero-median process squared (as in Fig. 29) . . . . . *griseum, notatum*
– Scutum with distinct median stripe or with

seven stripes of alternating color, either orange or brown-black and silvery white-blue. Anal lobe in ventral view with posteromedian process digitiform (as in Figs. 30, 32) to broadly triangular (as in Fig. 31) 4

4. Scutum with single reddish brown or black median stripe 5
– Scutum with three orange-brown to black stripes against silvery white-blue background 6

5. Scutum gray, with thin dark red-brown to black median stripe. Anal lobe with spiniform process (Fig. 36) . . . . . *venator*
– Scutum orange-brown with thin dark red-brown to black median stripe. Anal lobe with short, blunt ventral process (Fig. 37) . . . . *mediovittatum*

6. Process of anal lobe spiniform, its length three times its basal width (Fig. 35). Scutum with median stripe reaching posterior declivity of scutum. Katepisternum with faint blue pollinosity 7
– Process of anal lobe blunt or spiniform, its length equal to its basal width (Figs. 33, 34, 36). Scutum with median stripe not reaching posterior declivity. Katepisternum with considerable blue pollinosity 8

7. Known from southeastern AZ south to Jalisco and Morales, Mexico . . . . . *longithallum*
– Known from Oklahoma and Texas south to Escoahuila, Mexico . . . . . *trivittatum*

8. Scutum usually orange with silvery white longitudinal stripes (rarely dark brown-black with silvery blue stripes). Widely distributed in W Nearctic . . . . . *bivittatum*
– Scutum orange to dark brown-black with silvery-blue longitudinal stripes. Known only from CA . . . . . *clarum*

Males

1. Thorax, in lateral view, strongly arched, its anterior face nearly perpendicular to top of head (Figs. 111, 113 in Peterson 1993). . . . 2
– Thorax, in lateral view, not strongly arched, its anterior face forming an obtuse angle with top of head 3

2. Scutum orange-brown, or at least trimmed with orange . . . . . *robynae*
– Scutum entirely gray-black . . . . . *labellei*

3. Scutum grayish green with variably visible, faint, dull black median stripe and lacking anterior silvery markings; spots (one/side) immediately mesad of postnotal lobes orange . . . . . *griseum*
– Scutum black (rarely solid orange) or black with thick median orange stripe and with anterior crescent-shaped, oval, or triangular silvery markings; spots immediately mesad of postnotal lobes pale brown 4

4. Scutum with pair of broadly triangular, iridescent coppery blue-green markings anteriorly extended just short of posterior declivity and broadly joined anteriorly to concolorous lateral areas . . . . . *notatum*
– Scutum with variably shaped, anterior, silvery blue (never coppery green) markings that, if extended near posterior declivity, are separated anteriorly from concolorous lateral areas 5

5. Scutum with silvery blue (rarely silvery yellow) linear markings, not noticeably tapered, and extended to posterior declivity. Ventral plate in ventral view with posterior margin broadly rounded and with pronounced anterodorsal flange (Fig. 40). Gonostylus with pronounced posterolateral flange (Fig. 45) 6
– Scutum with silvery blue markings linear, crescent-shaped, or narrowly triangular, and if extended to posterior declivity, then only barely perceptible. Ventral plate (as in Figs. 38, 39, 41–43) and gonostylus (Fig. 44) lacking flanges 7

6. Scutum with silvery blue (rarely silvery yellow) stripes nearly parallel-sided, not tapered posteriorly . . . . . *longithallum*
– Scutum with silvery blue (rarely silvery yellow) stripes broadest anteriorly, slightly tapered posteriorly . . . . . *trivittatum*

7. Scutum with silvery blue stripes tapered strongly posteriorly, usually reaching posterior declivity. Ventral plate in ventral view triangular, with pointed, inwardly directed arms and pointed lip (Fig. 43). Known only from Texas . . . . . *mediovittatum*
– Scutum with silvery blue areas linear, crescent-shaped, triangular or oval, rarely reaching posterior declivity. Ventral plate in ventral view roughly squared (Fig. 41), rectangular (Figs. 38, 39), or if, roughly triangular (Fig. 42), then arms and apex of lip blunt. Widespread 8

8. Scutum with silvery blue areas narrowly oval to triangular, contiguous anteriorly with concolorous lateral areas. Stem vein setae yellow. Ventral plate in ventral view roughly square (Fig. 41) to roughly triangular with blunt ventral lip (Fig. 42); arms of ventral plate rounded apically and dramatically darker than remainder of structure (Figs. 41, 42, 56) . . . . . *venator*
– Scutum with silvery blue areas linear to crescent-shaped, separated from concolorous lateral areas. Stem vein setae yellow or golden brown to brown. Ventral plate in ventral view roughly rectangular (Figs. 38, 39); arms of ventral plate acute, not noticeably darkened 9

9. Ventral plate in terminal view arctate with ventral margin not strongly concave (Fig. 47). Ventral plate in lateral view with dorsal margin concave (Fig. 53). Setae of stem vein and

wing base pale golden brown to brown. Silvery blue stripes of scutum regularly extended ½ the distance to base of wing and rarely to posterior declivity ..... *clarum*

– Ventral plate in terminal view arctate with ventral margin strongly concave (Fig. 48). Ventral plate in lateral view with dorsal margin not noticeably concave (Fig. 54). Setae of stem vein and wing base invariably pale yellow. Silvery blue stripes of scutum never extended more than about ½ distance to base of wing ..... *bivittatum*

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